

A study of the individual activity of professional volleyball players: Situation assessment and sensemaking under time pressure

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ABSTRACT

The aim of this study is to understand interindividual differences in defensive behaviour in elite volleyball players facing similar game situations. This recurrent observation leads us to adopt an activity-centred ergonomic approach. Two case studies are conducted in naturalistic contexts. In the first, thirty-one professional players are observed in order to account for typical forms of behaviour in relation to certain specific sets of game situations. Two characteristic populations are distinguished. The second study uses observations and self-confrontation interviews with twelve players representative of each population in order to characterise their situation assessment. Results highlight important contrasts between the two populations, both in behaviour and in situation assessment. They suggest that one norm of activity centred on the rally-ending issue and another on the roles to be assumed, guide the specific coherency of these populations under time pressure. The identification of these norms provides a hypothesis concerning the foundations of sensemaking. Implications for training development are discussed.

1. Introduction

In the field of sport sciences, as in ergonomics, improving performance is a key issue. Having a common aim, several sports research projects have used ergonomics frames and referred to activity theories. These studies proposed first to grasp individual or collective activities, and second to consider ways to improve it. Focusing on individual activity, some research has characterised decision-making under time pressure in different sporting contexts (Bossard et al., 2010; Macquet, 2009; Neville and Salmon, 2015). They have pointed out the relevance of the perception-action coupling principle in order to understand what is going on in the athletes' decision-making. According to a predominantly French school, several works of research have also identified typical activity sequences and/or typical experiences in different sports (Hauw and Durand, 2005; Hauw et al., 2008; Saury and Durand, 1998; Sève et al., 2003; Sève and Poizat, 2005; Villemain and Hauw, 2014). The results highlighted common characteristics of several athletes' activities in the studied context. This leads to an underlining of similarities between the ways in which singular subjects act. Analysing the activity of ultra-trail runners, Hauw et al. (2017) also noticed certain differences and distinguished different patterns of activity related to runners' goals and levels of performance.

The aforementioned research aside, research showing differences

often relates to team activity in different sporting contexts (Bourbousson et al., 2011, 2012; Poizat et al., 2009; Sève et al., 2009). The main objective of such research is to study the degree, nature and content of shared knowledge, of shared contextual information and of shared perception between players of a same team. Most of the results revealed many player differences in situation assessments and ways of acting within the same team. Yet these interindividual diversities have so far only been studied with a view to demonstrating the limits of sharing within a specific team. However, in different sports, especially in volleyball, at the same level, players regularly exhibit interindividual diversity in defensive behaviours when facing similar game situations. This recurrent observation has led to a study which aims to understand this interindividual diversity and what underlies each individual player's activity. The study focuses exclusively on individual activity and point of view, including comments on teammates' behaviour. Why do elite players, equally motivated to perform and win, with equivalent physical conditions and capacities, act differently in an identical game context, when facing an identical ball trajectory? For example, why do some players decide to chase a ball that is out of reach (to relentlessly pursue every ball) whilst others do not? These issues and concerns led us to adopt an 'activity-centred ergonomic approach' to volleyball players, in order to understand the factors that determine different individual ways of acting when facing identical tasks. Our aim is both

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knowledge production and ergonomic action that might benefit coaches at elite level.

1.1. Activity-centred ergonomics approach: task and interindividual differences

Activity-oriented perspectives have created strong links between professional practices and theoretical frameworks in order to understand and develop work performance.

One key proposal in activity-centred ergonomics consists in distinguishing between prescribed tasks (prescribed work) and activity (real work), and in considering them together (Leplat, 1990). This approach stems from observations that “the same task performed by people of different characteristics will not generate the same activity” (Daniellou and Rabardel, 2005, p.355). This has prompted researchers to consider the extent to which an operator's activity (and his/her personal striving towards a goal) is related to constraints imposed by the objectives of particular tasks (Bedny and Karwowski, 2004a).

These perspectives share the following main points and participate in an epistemological paradigm that places human activity at the heart of both knowledge production and ergonomic action, as well as emphasising a range of conceptualisations and methodological approaches:

- activity is finalised, it is object-oriented in order to attain the subject's motives and goals, which are not always evident, and which the analyst may have trouble identifying;
- an activity-oriented approach is intrinsic and attaches considerable importance to interindividual diversity: it seeks to understand ‘from within’ how the subject constructs his/her activity to attain the object given the resources and constraints at his/her disposal. This contrasts with approaches in which behaviour is described as a reaction to events that arise (Daniellou and Rabardel, 2005; Klein, 2015).

This means that in order to understand an activity it is necessary to study the “significance, which derives from personal sense, influences the selection of specific information by an operator, developing strategies and criteria for the evaluation of task performance” (Bedny and Karwowski, 2004a, p.144). Similarly, Klein's work aims precisely to capture the strategies that domain practitioners use to make sense of complex situations in real-world contexts where data elements are not clearly specified. Klein et al. (2006) assertion is that when people try to make sense of events, they begin with a perspective, viewpoint, or framework, however minimal, that they call a *frame*. Even though frames define what counts as data, they themselves actually shape the data. This view of sensemaking posits continual interplay between data and frame: “Our naturalistic investigation of sensemaking found that people are not simply selecting data, they are actively constructing the data” (Klein, 2015, p.57).

Recent work conducted within the enactivist approach also proposes a conception of sensemaking that focuses on the active construction of data (i.e. data enaction). It follows Merleau-Ponty's phenomenological account of activity and emphasises that cognition is not the representation of a pre-given world by a pre-given mind but is rather the enactment of a world and a mind based on a history of the variety of actions that a being in the world performs (Varela et al., 1991). Every agent is a centre of activities and perspectives who produces and sustains its own identity in precarious conditions and challenging situations, and thereby establishes a perspective from which interactions with the world acquire a normative status. Merleau-Ponty (1963, p.148) suggests that “each organism, in the presence of a given milieu, has its optimal conditions of activity and its proper manner of realising equilibrium” and that each organism “modifies its milieu according to the internal norms of its activity” (p.154). Basic cognition is not a matter of representing states of affairs but rather of establishing

relevance through the need to maintain an identity. In this way, according to the enactive approach, behaviour in a particular physical, human, social, or cultural context is governed by the norms of the subject's own continued existence (Di Paolo and Thompson, 2014). The hallmark of cognition is the normative regulation of environmental interactions (agentivity) in terms of sensemaking (Di Paolo, 2010). “Sensemaking describes behaviour or conduct in relation to norms of interaction that the agent itself brings forth on the basis of its adaptive autonomy” (Di Paolo and Thompson, 2014, p.72).

Studying the sensemaking and approaching the norm that orients it might thus allow us to understand a subject's activity and the differences between subjects facing the same task.

1.2. Volleyball and prescribed defensive tasks

We therefore focus on both the task and the player's activity. Concerning “tasks”, the constraints that pre-exist players' activities are of a regulatory nature. The rules of the game relate to a set of specific formal properties and establish a reference system which shapes players' behaviour (Darbon, 2010; FIVB Volleyball Rules). Volleyball can be compared to a meta-task (a goal, criteria for success, constraints on operations, a specific environment): it is a rally-based ball game opposing two teams on a playing court divided by a net. The ball is put into play with a service. It must never be caught and/or thrown. Each team has three hits in which to return the ball (in addition to the block contact). The rally continues until the ball is grounded on the playing court, goes “out” or until a team fails to return it properly (FIVB Volleyball Rules). Volleyball is governed by official rules that clearly specify expected performance and stipulate and control under what conditions it is carried out. The study and evaluation of performance and expertise are facilitated by this regulatory reference. A set of sport specific culturally constructed techniques (overhead pass, bump, hit, etc.) or organisational knowledge/systems (positions and roles, strategic and tactical game systems, etc.) are also essential references and resources for effective action. Furthermore, the players have to adapt to the ball's physical and spatio-temporal parameters as it flies through the air and thus cope with high time pressure, ill-structured problems and uncertain dynamic environments (Macquet, 2009). In a way, these factors are components of a prescribed facet – an external source of reference.

Whilst the game is centred on rally ending, three reasons led us to focus on defence (i.e. avoiding rally-ending being detrimental to one's own team). Firstly, as we have pointed out, it is in this domain that behaviour differs most. Secondly, winning the rally presupposes that the team has first avoided losing it. Thirdly, coaches have long requested intensive defensive commitment. Selinger and Ackermann-Blount (1986) affirm that all players must take part in defensive play and that each player must feel constantly concerned with balls to be defended. “Never give up”, “give it your all”; the commitments and comments shown in the photos below are highly valorised and strongly prescribed.

1.3. Volleyball and the defensive player's activity

Over and above task analysis, activity-oriented ergonomics leads us to consider the subject's activity in its naturalistic setting (Cuvelier and Falzon, 2015; Leplat, 1990; Theureau, 1992). Activity is always singular; it is specific to a particular individual in a particular context. It is rooted in both the subject's history and past experience, and in a particular human physical, technical, and organisational context (Daniellou and Rabardel, 2005). Starting from what a subject does - which is partly observable - in a particular naturalistic context, analysis of the activity aims at “the understanding of the situation by the operators and in general the meaning they attach to the information or events that occur” (Grosdeva and Montmollin (de), 1994, p.306). This, therefore, means understanding not only what actually happens but

also the subjects' affective and cognitive processes underlying the accomplishment of the task.

With this approach, in order to understand and improve performance it is crucial to consider not just behaviour but also the situation assessment. The relevance of studying the situation assessment of volleyball players is supported by Macquet's study (2009). Reinforcing the Recognition-Primed Decision model (Klein, 1997), she shows that players' decision-making consists of two steps: situation assessment and choice of a course of action. The assessment of the situation is based on a process of recognition regarding the typicality of the situation. This process includes four by-products: (a) perceived relevant cues, b) expectancies or anticipation regarding situation development and player action, (c) plausible goals to adapt to situation development, and (d) reference to a typical action linked to the specific conditions of the game situation. Macquet's results (2009) relate to the specific character of high-pressure time in volleyball and led her to make key suggestions concerning the goals. The first is that in volleyball, time-pressure is so high that the players do not have enough time to consider several goals and then to implement one of them. To cope with high time-pressure, volleyball players may therefore refer to their team's game system. Game systems consist of preliminary options for a team's collective offensive or defensive organisation, establishing a precise tactical device on the court. They also determine certain tasks assigned to players and the principles of collaboration between them according to their position on the court and to the current game situation. The second suggestion is that a given decision is made in relation to the developing situation. Players do not report all the information they perceived during the decision-making process, but only the critical cues for the situation they described from their own point of view, according to their own roles and functions within the team and in relation to the situation. This underlines the important influence of the player's role, function and position on the court on the process of situation assessment.

However, this cannot fully account for the significant differences in the players' defensive behaviour that are at the origin of this study. Indeed, in defence, the roles and functions of the players are quite similar and belong to the same game system for a given team. Selinger and Ackermann-Blount's proposition (1986) that defence skills are essential to all players and that all players should be *de facto* defenders, is

widely shared by the coaches. “Never give up”, “give it your all”; defensive commitments appearing in the image (Fig. 1) shown above are strongly valued and prescribed ... because they are not often manifested! Despite coaches' request for constant and intensive defensive commitment, Selinger and Ackermann-Blount (1986) note that “it is not rare that a player does not react if the ball does not arrive directly at him” (p.238). This is the main enigma. Although situation assessment partly depends on the characteristics of the task, our research aims to understand what underlies the interindividual differences in defensive behaviour between elite players. Might other dimensions of situation assessment, which have so far not been studied to any great extent, be involved? Many current scientific debates consider (1) the relationship between the current action and “what counts as data in the first place”; (2) the way certain cues are recognised as relevant (Klein, 2015; Endsley, 2015). This study attempts to address this issue within a specific context.

For activity-centred ergonomics, analysis of activity - which is a primary concern - is a joint production. It requires an interaction between the analyst and the subject and cannot be based purely on behavioural observation (Daniellou and Rabardel, 2005). In order to identify typical forms of behaviour and situation assessment, we therefore conducted two case studies in naturalistic contexts (i.e. real matches). Three of the authors of this research are very familiar with volleyball, and benefit from a lengthy immersion in the game, as players, teachers and coaches, which has fostered their participating observation. The first study aimed to identify typical forms of defensive behaviour in relation to certain specific sets of game situations, while the second focused on data collected during self-confrontation interviews. For both studies, the key methodological assumption was “whatever the type of autonomous system we study, we can only approach it on the basis of certain regularities in its behaviour [...] because we have access to both the system's functioning and its interactions” (Varela, 1989, p.10). Notice that when Varela refers to an “autonomous system”, he means any living system – in this case, any volleyball player. Our methodological procedure is based on the primacy of regularities identified by the researchers. The first study concentrates on the regularities of defensive behaviour but also on the regularities of the game situations in which these behaviours are regularly manifested. The second study focuses on the regularities of

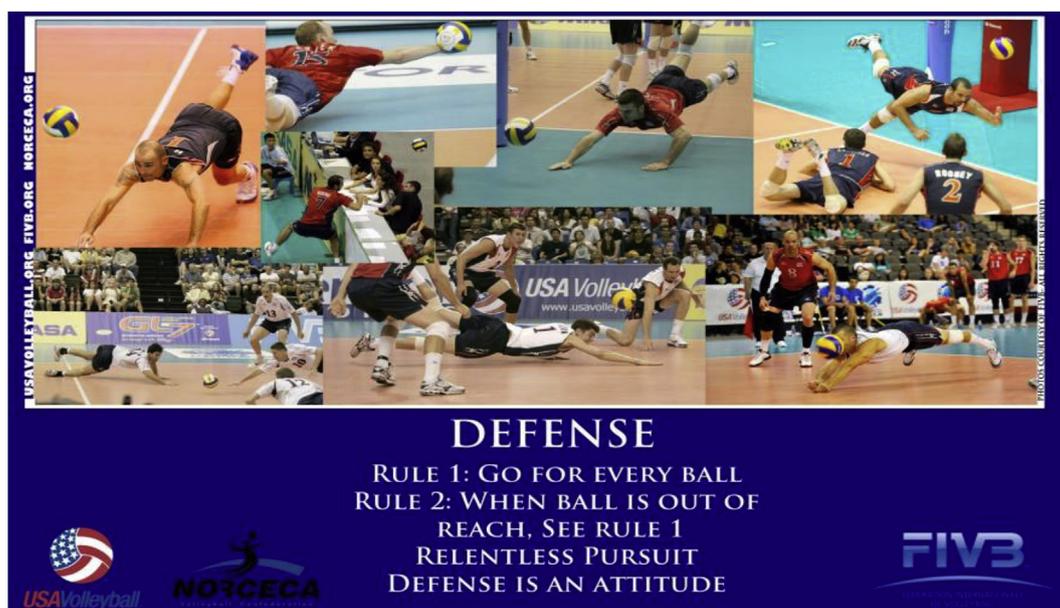


Fig. 1. Some images of defensive commitment.

(<http://www.teamusa.org/USA-Volleyball/Grassroots/Multimedia/Posters>)

Table 1
Correspondence between behavioural regularities and the situational regularities in which they are detected.

Criteria of behavioural regularity	Criteria of situational regularity
<i>Before playing the ball, in relation to its flights: Characteristics of body posture</i>	
Detailed behavioural indicators relating to this criterion	captured in that specific set of game situations (these will be detailed in the following items)
-
-
<i>Characteristics of player intervention: Moves towards the ball to play it</i>	
Detailed behavioural indicators relating to this criterion	captured in that specific set of game situations
-
-
<i>After losing the rally due to a failed defensive action: Results-based dissatisfaction reactions</i>	
Detailed behavioural indicators relating to this criterion:	captured in that specific set of game situations
-
-

meaning arising from self-confrontation interviews centred on the regularities identified during the first study.

2. First case study

The aim was to capture observable criteria that would allow us to identify regular interindividual differences in defensive behaviour during matches.

2.1. Method

2.1.1. Participants

Thirty-one professional male volleyball players from two national teams were observed during three competitive matches in the World League, an annual international men's volleyball tournament. They ranged in age from 22 to 35 years old ($M = 27.2$ years, $SD = 4.8$ years). With one exception (7 years), they had all been playing volleyball for more than 10 years.

2.1.2. Data collection

These are data recorded during the competitive matches and then observed. We carried out audio-visual recordings of volleyball players' defensive activity during the first two matches. Playing time was recorded in its entirety using a wide-angle lens with the camera only being turned off when there was no real game time (i.e. time-outs, intervals and teams changing sides between sets). The video camera was statically positioned in line with the net and slightly above it. A view from above made it possible to record behaviours of all the players present on the court while at the same time offering a vision of all situations throughout the entire game. The images shown above in Fig. 1 correspond to the types of defensive behaviour in game situations upon which we have focused our observations.

2.1.3. Data processing

Using the video recordings, we conducted a systematic observation of the players' behaviour in specific defensive situations. As accurately as possible we described player behaviours and the main characteristics defining the situations during which they occurred.

Our processing was in line with Bartlett's principle of a non-identical reproduction of behaviours because each is enshrined in a singular context, which founds the very principle of schematisation linked to a specific set (or classes) of similar (but non-identical) situations:

“Suppose I am making a stroke in a quick game, such as tennis or cricket. How I make the stroke depends on the relating of certain new experiences, most of them visual, to other immediately preceding visual experiences and to my posture, or balance of postures, at the moment. The latter, the balance of postures, is a result of a whole series of earlier movements, in which the last movement before the stroke is played has a predominant function. When I make the stroke I do not, as a matter of fact, produce something absolutely new, and I never merely repeat something old. The stroke is literally manufactured out of the living visual and postural 'schemata' of the moment and their interrelations. I may say, I may think that I reproduce exactly a series of text-book movements, but demonstrably I do not; just as, under other circumstances, I may say and think that I reproduce exactly some isolated event which I want to remember, and again demonstrably I do not.” (Bartlett, 1932, p.202).

This is also congruent with Bernstein's famous formulation of repetition without repetition of movement (Bernstein, 1967).

Similar data and criteria have been captured in a previous work (Récopé et al., 2013) and served as a preliminary basis which was modified for the systematic observation of this study in accordance with four concerns. Firstly, to avoid behavioural aspects that are difficult to objectify in ecological situations which present risks of low validity (such as gaze direction). Secondly, to only retain data (observations of behaviour and sets of game situations) for which there was total agreement between the three coders (the authors with expertise in volleyball analysis) after they had independently examined the facts. Any divergence was discussed until total agreement was reached. When this was not the case, the data were excluded. Thirdly, to only keep the behavioural regularities in some specific sets of game situations that are detectable in at least 70% of the occurrences that arose during the two matches [these recurrences were observed between 369 out of 413 real occurrences caught (89 percent in the most frequent case) and 191 out of 258 (74 percent in the least frequent)]. Fourthly, to not go into too much details, due to the risk of not being understood by readers unfamiliar with volleyball (all criteria and indicators are available on request from the first author).

The application of these four requirements resulted in behavioural criteria relating to situational criteria. This led to a three-phase investigation: before, during and after the intervention of players (see Table 1: to avoid cumbersome repetition, the most characteristic defensive situations are detailed in the results section).

The detailed behavioural indicators in relation to specific sets of situations allowed us to identify recurrences for each player over the course of the two matches. The results presented below specify typical aspects that characterise the main differences in defensive behaviour.

2.2. Results

The results are presented in three stages. First of all, two highly contrasted populations are differentiated on the basis of behavioural and situational regularities. We then place each player in one of the populations. Finally, we underline the main differences observed.

2.2.1. Two strongly contrasted populations

The behavioural regularities and the corresponding situational regularities in which they are detected led us to distinguish between two strongly contrasted populations for each of the selected criteria. Table 2 reports the observed differences between the populations (that we have named A and B).

2.2.2. Ranking of players in both populations

In accordance with established procedure, we assigned a player to a population once he displayed, within each of the specific sets of identified game situations, the corresponding behavioural indicators in at least 70% of the cases during both matches.

Among the thirty-one players observed, nine players were ranked in

Table 2
Typical defensive behaviour of populations A and B.

Population A		Population B	
Criteria of behavioural regularity	Criteria of situational regularity	Criteria of behavioural regularity	Criteria of situational regularity
<i>Characteristics of body posture</i>			
Instantly turn to face the ball. Systematic orientation of whole body towards the ball: pelvis, shoulders, and sight are always oriented towards the ball	<ul style="list-style-type: none"> - Whatever the position on the court or the ball's speed and trajectory when the player is back-row and when he is not involved in an imminent offensive combination. - During all defensive contexts, except in case of a fall. 	The head is oriented towards the ball (<i>following all its movements</i>)	<ul style="list-style-type: none"> - When a teammate's intervention sends the ball directly back into the opponents' court or immediately results in the loss of the point. - When it is in the opponents' court. - When a teammate makes contact with the ball.
Ready position for first-step speed: forearms raised, legs half-flexed, bust bent forward, shoulders further forward than the knees, dynamically balanced on balls of feet with the heels barely touching the ground	<ul style="list-style-type: none"> - The moment the ball is hit by the opposition server. - Right before the ball is hit by the opposition attacker. 	The whole body is oriented towards the ball	<ul style="list-style-type: none"> - When the ball is directed towards his specific area of responsibility following a service or opposition attack. - When he ought to be the next to intervene according to the pre-established game system. - When the ball is travelling on a downward curve towards a teammate's zone of responsibility. - Afterwards, when a teammate's intervention requires him to intervene unexpectedly. - When the ball is directed towards a teammate's area of responsibility. - When a high-speed ball is travelling towards the ground approximately 2 m from him.
<i>Rest position: upright, immobile, static, arms hanging or hands on hips</i>	<ul style="list-style-type: none"> - When the ball is rising towards the ceiling in the opponents' court. - When the opposing team is in precarious defensive situation for play building. 	<p>Just above the feet, feet anchored to the ground (not a proper fully ready position: a mixture of rest position and static ready position)</p> <p>Before contacting the ball: legs flexed in an immobile position (<i>a crouching movement</i>), on balls of feet, leaning forward, arms raised horizontally</p> <p>Direct transition from a rest position to one where one (or both) arms/hand(s) or one foot are thrown towards the ball (<i>not ready to intervene quickly</i>)</p>	<ul style="list-style-type: none"> - When the ball is directed towards his area of responsibility following a service or opposition return/attack. -When the ball is directed towards his area following a pass from a teammate. - When he ought to be the one to intervene according to the pre-established system of play. - In case of an incident in the team's development of play (not in line with the pre-arranged game system) when he is not the player who ought to intervene according to the pre-arranged game system.
<i>Moves towards the ball to play it</i>			
<i>Defensive rushes: numerous, intense, explosive movements to attempt to make contact with the ball</i>	<ul style="list-style-type: none"> - Just when the opposing attacker hits the ball. - As soon as a teammate's action produces a precarious defensive situation: whatever the position on the court, the trajectory of the ball, the distance between him and the ball. 	Movement with a delay of at least a half-second	<ul style="list-style-type: none"> - When the ball is sent accidentally towards him by a teammate. - When he ought not to be the next to intervene according to the pre-established game system. - When the ball is directed to the boundary between his area of responsibility and a teammate's. - When a teammate makes a clumsy serve receive or defence, provided that: - The teammate is near him. - And/or if the ball goes out of bounds, from his side of the court.
<i>Persistence of defensive actions:</i>	<ul style="list-style-type: none"> - Rushes towards the ball last until the ball is touched - No deceleration or raised chest until contact with the ball. - Several occurrences of impact with material items (ground, teammate, post, net, wall, bench, etc.). 	Movements with a delay of at least a half-second, followed by an acceleration	

(continued on next page)

Table 2 (continued)

Population A		Population B	
Criteria of behavioural regularity	Criteria of situational regularity	Criteria of behavioural regularity	Criteria of situational regularity
Change of mind and deceleration without touching the ball	<p>Only in three cases:</p> <ul style="list-style-type: none"> - The ball goes towards a teammate. - A teammate is closer to the ball (is more able to intervene) than he is. - The distance between the ball and the player is increasing (the ball is moving faster than the player and goes out of reach). 		
<i>Results-based dissatisfaction reactions</i>		<i>Results-based dissatisfaction reactions</i>	
Head hanging or raised towards the ceiling; hands joined at chest level or temples; but fully bent forward hitting the ground with hand, etc. (<i>manifestations of vexation/frustration</i>)	<ul style="list-style-type: none"> - When the opponent's serve or attack hits the ground in their court (so-called aces). - Whatever his position and wherever the ball lands. 	<ul style="list-style-type: none"> - Head hanging or raised towards the ceiling; hands joined at chest level, tightening of lips, narrowing of eyes, etc. (<i>manifestations of vexation/frustration</i>) 	<ul style="list-style-type: none"> - Only in the case of a failed personal defensive action when the ball arrives close to them: they play the ball but their intervention directly causes the point to be lost.

population A, eighteen players in population B. Four were judged to be intermediate cases and were not taken into consideration due to our processing and agreement requirements.

2.2.3. Distinction of populations based on behavioural comparison

The defensive behaviour of the players in population A and in population B is thus differentiated in terms of body posture characteristics before playing the ball, in relation to its flight. While the former systematically orient their bodies towards the ball, the latter tend to orient their heads towards the ball, except in a certain number of conditions essentially relating to a predefined responsibility to intervene in the present or future (depending on assigned areas and roles). Their postures are different. Population A players are characterised by frequent switching between a ready position and a rest position, while population B players are often in an intermediate posture generating a “crouching” movement just before making contact with the ball. There is also a contrast with regard to the characteristics of player intervention: these characteristics relate to the moment when movements towards the ball are triggered, and to the circumstances in which they occur, their intensity and persistence. Many rushes and relentless pursuits are made by population A players who move sooner, farther, and faster than those of population B. Lastly, whilst reactions of dissatisfaction are seen in all players, the conditions in which they can be observed are different: for population A players, when the ball is directly grounded on their playing court without being touched by them or by one of their teammates; in cases of personal failure for population B.

Thus far these comparative descriptive results highlight various aspects that make it possible to objectify and qualify a difference in defensive commitment between two populations of observed elite volleyball players. This differentiation between these two populations allowed us to carry out a second study in order to understand what underlies that difference.

3. Second case study

The aim was to determine whether, during the self-confrontation interviews, there was any regularity concerning the components of the meaning underlying the situation assessment between the members of each of the two populations. It was also to capture any regular difference in elicited meaning between these populations.

3.1. Method

3.1.1. Participants

We relied on the results of the first study to select participants. Of the thirty-one players observed during study one, fourteen players were solicited. We described the study to them and asked them if they would volunteer to take part. Thirteen of the fourteen players consented to take part in this study. As one player from population A refused to fully participate, we extracted a randomly chosen player from population B and finally retained twelve players (6 representatives from population A, comprising 3 members of each national team, and 6 representatives of population B, comprising 3 members of each national team). Participants were between 23 and 32 years of age (M = 26.7 years, SD = 3.6 years). With one exception (7 years) they had all played volleyball for more than 10 years.

3.1.2. Data collection

In this study, two types of qualitative data were collected. Data recorded during two other matches opposing these two national teams in the same World League tournament. We carried out audio-visual recordings of these twelve players' activity with focus on relevant extracts of film concerning their actions during the selected defensive situations identified from the results of study 1. These recordings formed the database for the self-confrontation interviews

(Theureau, 1992) which were designed to re-immers the players as closely as possible in their *in situ* playing (Omodei et al., 1998).

The data were collected during self-confrontation interviews with each of the twelve participants after they had played the last match. They were conducted by the same researcher, who has expertise in volleyball analysis and in the methodology of conducting elicitation interviews, between the 2nd and 4th days following that match. During these interviews, the players were induced to document their broadly implicit, pre-reflected experiences (Vermersch, 1999). The interviews were structured to elicit information and salient features taken into account by the players. They were invited to show and comment on certain events that they felt to be meaningful (Theureau, 1992), through open questions relating to their focalisations (for you, what is happening at that moment?), feelings (how do you feel at that point in time?) and acts (what are you doing at this specific moment?). The subjects could control the videotape at any time, stop it, or replay all or part of a sequence to make explicit something that they deemed important. We encouraged them to expand on their elicitation or explore it in greater depth; we avoided influencing them or confining them within an explanatory, evaluative, or justificatory register (Theureau, 1992). Attention was focused on the phenomena as perceived by the players (in relation to what they say and feel about the event as they perceived it). Each interview lasted approximately 1 h and was fully transcribed.

3.1.3. Data processing

The data were processed in five steps: (1) compiling short accounts of relevant situations during self-confrontation with each player, (2) analysing the short accounts in relation to the categories of salient features taken into account by Macquet (2009) for each situation (3) comparing the accounts of the six members of each population to capture any regularity concerning the components of the meaning underlying the situation assessment, (4) comparing these possible regularities of account in order to check any regular difference in elicited meaning between these populations, (5) establishing generic principles that induced the major orientations identified in each population's account.

In the first and second phases, the data were processed in relation to the four categories of salient features identified by Macquet (2009) in order to document the situation assessments of the twelve players. In this way, for each relevant defensive situation observed, we asked the players to try to specify their own (a) relevant cues (opponents' actions; teammates' actions; the player's actions; ball trajectory), (b) expectancies (opponents' abilities and tendencies; teammates' abilities and tendencies; the player's abilities and tendencies), (c) plausible goal and (d) typical action (rules; a prior event; consequences of the course of action). Even though not all of the by-products were systematically documented by every player in all of the viewed defensive situations, the verbalisations obtained enabled us to examine the recurrences of contents of meaning for each player.

The purpose of the third phase was to compare these regular accounts by the members of each population in order to capture any regularity concerning the components of the meaning underlying their situation assessment. These regularities were constituted in accordance with their semantic proximity. Despite a wide variety of lexical expressions and formulations – expressing different linguistic and reflective capacities – certain pieces of content appeared to have similar meanings and were considered to belong to the same category. For example, we noted common recurrent statements relating to the category concerning 'intense pleasure accompanying the success of a defensive intervention' among various population A members, such as: "the opponent's attacking hit is difficult to defend and I manage to save the ball and make it playable - that's what I love most" or "I'm never more ecstatic than when someone defends".

The fourth phase compared the generated regularities in order to identify for any regular difference in elicited meaning between these populations.

The fifth phase consisted of establishing, for each of the categories, the generic principles that condense the main orientations characteristic of the verbal reports made by players from each population. For example, the Expectancies of population B players focus on one absolute necessity: that everyone must do the job he has been set (almost a contractual obligation) as a team member (take responsibility for his role and respect the game system).

In order to enhance the validity of these semantic categories during the last four phases, the three authors (out of five) with expertise in volleyball analysis independently processed the interview data. Each divergence was discussed until an agreement was reached; only the recurrences for which total agreement had been reached were considered. An overview of these processing outcomes, focusing on the features considered by Macquet (2009), is presented in Table 3.

3.2. Results

The results are presented in three stages. First of all, we set out the components of the situation assessment for each population. We then stress the fact that the specificity of these components allows us to differentiate between the two populations. Finally, a comparison of the behavioural regularities and of the components of the situation assessment reveals a specific coherency for each population's activity, with a specific orientation at its origin.

3.2.1. The components of situation assessment: similarity within each population, differences between the two populations

These are reported below in Table 3 focusing on the characterisation and specificities of the components of the situation assessment for each population.

3.2.2. Specificities in the components of the situation assessment for each population

For each population we identified recurrences relating to the components of the situation assessment (a) relevant cues, (b) expectancies, (c) plausible goal, and (d) typical action. Table 3 lists the various by-products of the specific salient features proposed by Macquet (2009). This table reports typical verbalisations and also provides a synthesis of the recurrences noted for each by-product; these recurrences enabled us to induce certain orientations. We thus find that the relevant cues for population A – whether relating to opponents' actions, teammates' actions, the player's actions or the trajectory of the ball – are recurrently related to the more or less dangerous nature of the situation with regard to the risk of losing the rally as well as to the moment when this danger becomes evident. Population B cues are related to situations with an immediate outcome for which they - or a teammate - are responsible. Nor are the expectancies of the two populations of the same nature: some are based on the link between the need to avoid losing the rally and the resources or obstacles required; others are supported by a reference to the pre-established game system and to the specific role of each player. Likewise, the "obvious goals" are different in both their content and their nature. For population A defending is an imperative and a necessity whereas the players in population B construct a plausible goal relative to their intervention's chances of success. Lastly, typical actions are constructed on different foundations: principally the moment and place where the danger of losing the rally arises for population A, whereas those of population B players relate to their specific role and position, and to their teammates' interventions or chances of intervening.

3.2.3. The consistency specific to each population

The systematic comparison of regularities in the behaviour and recurrent orientations of the components of the situation assessment specific to each population, revealed a strong consistency. This interpretative work highlighted a particular orientation underlying the activity for each population studied.

Table 3
Characterisation and specificities of the components of the situation assessment for each population (Examples of short accounts selected from different self-confrontation interviews).

Categories identified by Macquet (2009)		Population A	Population B
	Categories of salient features	Verbal reports	Verbal reports
Relevant cues	Opponents' actions	The [opponent] setter is a front-row player that's when I begin to intervene, because at that moment in time the ball might arrive on our side: the setter might feint a pass and then surprise us with a direct attack.	It was well played by X [the opposing attacker].
	Teammates' actions	The ball comes back high so it's playable; the problem was he didn't go for it [to defend it], because he was too late.	But then Y [a teammate] made a poor reception. In fact Z [a teammate] should've taken it.
	Player's actions	Sick to see the ball land on the ground because he hasn't done his job. I was caught on the wrong foot, but I still went for it knowing I wouldn't get the ball. One thing's certain, at this level I shouldn't be making a [defensive] mistake like that.	I see the ball going towards him and he's ready to return it. I see the ball's coming towards me, I take it. I leap to block it because that's my job. As soon as I served I quickly repositioned myself. As it turned out I didn't play it [the ball] very well but I repositioned myself. The ball was quite low; I wouldn't have had time. I was really too far from the ball to be able to try anything.
	The trajectory of the ball	It's an opposition defence; it isn't going to reach me. Or if it does, I'll have enough time to do what I have to do.	The ball was quite low; I wouldn't have had time. I was really too far from the ball to be able to try anything.
Expectancies	Expectations	I was expecting him to do that in fact. There's a defence [by the opposition]; you know the ball is not going to come to you.	It was really up to X to take it. Everyone has his position and under no circumstances can you pinch someone else's.
	Opponents' abilities and tendencies	When the match starts hotting up, the setter's going to give the ball to the best hitter. X for instance, doesn't attack a pure line, i.e. near the line. He has a technical gesture that hits an inner line. The setter [opponent], when he's in the front row, he's a guy who only attacks on the second hit, my meter's going to be red-hot all the time when the setter is in the front-row, because all the time I know he's going to do it ...	Ok, I do my job so then I let the others do theirs. On seeing what the setter's doing I know it's not going to be [for] the middle attacker. The setter's going to give the ball to the attacker who's on the side - me, I have to have a position in relation to the game system our manager's given us. I try to carry it out to the letter and so there you are, I tell myself that if the attacker on the side wing makes a big diagonal attack it'll be for me, so I have to be in that area.
	Teammates' abilities and tendencies	All the same he's not someone who's going to defend in every direction. He'll do it for certain periods: he'll fight when he gains confidence.	We're a team so everybody know what he's got to do; we respect that. I have confidence in my teammates; usually they're well positioned. They do their job too. Do all I can to cover my area so I can't be blamed for not having done my job.
	Player's abilities and tendencies	I say "go, go" straightaway; because once I touch it [the ball] I know it'll be playable, because I know immediately when the ball isn't going to be playable. Again, when I touch it I say "go" every time ...	It's when the opponent touches the ball that I know it might come back to me. That's why I get down - so that I am ready.
Plausible goal	Plausible goal	The ball mustn't touch the ground, it must absolutely not touch the ground. If the guy throws a bomb 2 m away [from you] you'll never reach it. Nevertheless, if it happens at 50 cm, 1 m you must touch it.	It's harder to receive the ball when it arrives high and behind you. I did my job so I let the others do theirs.
Typical action	Rules	Now, I know which situations are dangerous, very dangerous, and which are favourable for us, well, when I say favourable I mean they are not yet dangerous, you know. The aim of volleyball is that the ball mustn't hit the	Plausible goal Related to the intervention's chances of success Typical action Relating to: - the position and place occupied (continued on next page)

strong difference between two populations of elite volleyball players even when they are members of a national team and even though they are expected to apply the same game system. These results suggest that their individual activity must be considered as a whole, presenting a structured character; “as opposed to a mere combination of elements, a whole formed of mutually supporting phenomena so that each depends on the others and can only be what it is in and through its relationship with them” (Lalande, 1991, p.1032). By identifying two modes of internal coherence through behavioural and situational regularities, and the recurrent orientations of the by-products of the situation assessment, our results and interpretations may help to understand what underlies and forms the basis of this totality. It is a broadly implicit prevalent norm centred on the rally-ending issue which orients the activity of population A, a norm centred on the roles to be assumed by population B members. The identification of this norm organising and orienting the activity enhances the comprehension of the activity as a coherent totality. This norm has the status of a structuring element, defined by Lalande (1991) as an “overall orientation dominating a mentality and organising it around a guiding value” (p.1032). The various components of activity (behavioural facet and assessment by-products) appear to be the contextual actualisation, at various moments and according to the current circumstances of the play, of a broadly subconscious sense-orienting individual activity. This norm would appear to be the ‘motive-goal’ vector that mobilises activity into coherent structure (Bedny and Karwowski, 2004a): it constrains and organises what the situation means for the subject and for the actions to be performed. Our results support Canguilhem’s assertion (2008) that one cannot understand actions without appealing to the notion of proper norm and related privileged behaviour. It sets out the frame for actions to be taken: “we cannot determine the normal by simple reference to a statistic mean but only by comparing the individual to itself, either in identical successive situations or in varied situations” (p.129).

4.2. The sensemaking issue

We believe we have identified two distinct norms that perform two particular modes of normative regulation of environmental interactions. Each norm organises the subject’s point of view and establishes the coherency specific to his/her activity. It would appear that the identification of the norm orienting the activity - and enabling its comprehension - is essential for ergonomic intervention. As we pointed out, one main assumption of the activity-centred ergonomic approach is that activity is object-oriented in order to attain the subject’s motives and goals, which are not always evident, and which the analyst may have trouble identifying. Taking an interest in such a broadly subconscious norm is a way of approaching one of the essential factors determining the activity, at cognitive, energetic and affective levels. This appears to be a pre-requisite for its transformation, in so far as it circumscribes what is relevant, what constitutes a resource or on the contrary an obstacle when carrying out the task. It serves not only as a frame for selecting data, but also actively constructs the data (Klein et al., 2006). This constitutes an interpretative hypothesis explaining the foundations of sensemaking; later work must examine the extent to which the latter is compatible with Weick’s proposition (Weick, 1995; Weick et al., 1999) which focuses on how people work to make sense of the information and situations in which they find themselves.

Making progress in the intelligibility of the subconscious aspect of sensemaking is a primordial scientific issue. Our results are useful in this respect. They suggest that how the situation is understood from within, i.e. the meaning that the actors attach to the information, which can be formalised in the components of the situation assessment, is important but nevertheless appears to be insufficient. As we have shown above, comprehension of the activity as a coherent totality requires the identification of the broadly implicit norm orienting the activity. This norm constrains data and meaning construction; it refers to sense conceived as a structuring element that lends activity its

directedness, its orientation towards a particular object (i.e. the rally-ending issue for population A; the roles to be assumed for population B). It seems to be an essentially subconscious motive (Bedny and Karwowski, 2004a) which is different to what “is significant for the subject” (Bedny and Karwowski, 2004b, p.122). Following Klein (2015), we suggest that whatever the theoretical frameworks may be, future research should attempt to clarify not only what relates to sense and what relates to meaning, but also what relates to the processes that link them in different cases (“deliberate sensemaking” as opposed to “automatic decision processes” for example). Our study shows that by approaching the prevalent norm orienting the activity we can understand a subject’s activity and the differences between the subjects. Even if the subject is involved in decision-making that presupposes mental simulations and/or a diagnosis of the situation (Klein, 1993, 2008) or again if, faced with a situation that is still undetermined, the sense-making is in the nature of an inquiry (Weick, 2001), the subject’s cognitive flow is incorporated within the frame oriented and organised by this subconscious norm. Like research on the situation assessment (Neville and Salmon, 2015), the study and conceptualisation of subconscious sensemaking represent an issue that traverses various disciplines, particularly ergonomics, management, psychology of work, psychology of sport and sport sciences. In this perspective, the theoretical cross-fertilisation between the enactive approach, activity theories, and the Naturalistic Decision-Making may reveal fruitful complementarities.

4.3. The high time-pressure issue

Our study suggests that a distinction must be made between the two populations of players we identified, with regard to their relationship with high-time pressure in a defensive context.

Population B, whose norm of activity is centred on the roles to be assumed, would appear to cope with time pressure, as Macquet’s results (2009) suggested, by strictly adhering to the team’s game system. They attach great importance to their roles, functions and positions on the court and their actions are performed according to their position and to the current game situation. In this case, the purpose of using a game system is to make faster and more efficient decisions (Neville and Salmon, 2015). However, our results show that this is not the case for all elite volleyball players.

For population A members, whose norm is centred on putting an end to the rally, the fear of ending the rally at the expense of their team spontaneously causes them to assess situations as more or less dangerous. It can be assumed that under high time-pressure, their internalised norm of activity leads them to spontaneous, immediate and intense reactions that make them transcend roles and current positions on the court, but also to escape the prescribed game system at least in emergency defensive situations. Given the small sample size, this hypothesis must be considered with caution and future research should examine this issue in greater detail. The hypothesis is nevertheless consistent with Rochlin’s (2011) analyses conducted as part of the High Reliability Organisation Project: in crisis or emergency situations, the most reliable operators are convinced that their activity presents inherent risks, and that their environment is potentially hostile. This is the case for these players: “when I say [the situations are] favourable I mean they are not yet dangerous, you know”. These operators are remarkable for their particular sensitivity to alarm signals and their ability to react quickly to unforeseen events. The ergonomics of risk management organisations thus account for the advent of a state of high alert and the differential reactivity of individuals.

4.4. How might elite coaches use this work?

According to Selinger and Ackermann-Blount (1986), players must first defend intensely and be negatively impacted by the loss of the rally. Study 1 makes it possible to identify players with strong defensive

commitment, or even to recruit players on the basis of the behavioural and situational indicators.

Study 2 provides insights into the underlying entity (the prevalent norm of activity) that determines this defensive commitment. In identifying its main features, it offers a gateway to training which has as its stake the internalisation by the players of the norm centred on putting an end to the rally, and can help address this issue. Discussions are already underway with the technical staff of the national volleyball federation of one of the two teams observed. One of the main consequences of our studies is that priority should be given to the defensive avoidance of losing the rally in any volleyball game system (i.e. a strong defensive commitment). This does not mean, of course, that options for offensive or defensive organisation, assigned tasks and principles of collaboration between players are unimportant. During the next seasons, the national team achieved excellent international results. It is important to note that this team made considerable use of seven regular first-team players who, according to our analyses, were all identified as being centred on the rally-ending issue. The advantage is that these players have a field of interaction that is larger and wider both terms of time and space (we must remember that players in population A move sooner, farther, and faster than those of population B) in more game situations and they transcend their attributed roles. For example, the national team's setter, who determines strategy and directs play, is first and foremost deeply committed to defence before concentrating on his decisive role in his team's game-building.

Our results suggest that for effective training to be developed, it is essential to take sensemaking into account. Training must involve developing typical actions consistent with the norm that orients and organises the learner's activity, and must make the learner internalise a norm that is highly esteemed, both socially and culturally (see Fig. 1), by a community in professional practice, sport, or leisure. Volleyball is a sport where performance revolves around the rally-ending issue; identifying the norms that govern the activity of the players may enable training for population A to be oriented towards new courses of action, and training for population B towards constructing a new norm. The role of the coach might therefore be different depending on the norm governing player activity. If the norm of the players is centred on the rally-ending issue – as the most socially and culturally esteemed norm –, the coach could continue to develop and reinforce associations between a typical situation and a typical action, to help players learn, during the play, what cues are critical to avoid losing the rally (Macquet, 2009). The instructions, tactics and techniques provided by the coach are adapted to the players' needs and to their strong reflexivity. If the norm of the players is centred on the roles to be assumed, the coach might – indeed should – confront them with tasks that accentuate the rally-ending issue. According to Selinger and Ackermann-Blount (1986), whether a player is setter or hitter, he must first and foremost defend – that is to say before, during and after the attacking hit. In order to achieve this objective, all tasks – even those considered as technical repetitions – must relate to the rally-ending issue and to the spatio-temporal crisis with which players have to cope. These tasks are all opportunities for players to internalise and to feel that playing volleyball cannot be reduced to filling just one role. In this manner, coaches can lead players to construct a new norm centred on the rally-ending issue. This is an important challenge, because the core of this training is to transform the activity of individuals 'from the exterior', while attributing to them an essential autonomy (Poizat et al., 2016).

4.5. Limitations and future work

This research presents several limitations. Firstly, the sample size is small, especially in the second study, in which only twelve players participated. Our suggestions and hypothesis must therefore be considered with caution and future studies using similar methodology with larger samples will be required to further explore the robustness of the above results.

Even if we believe that ergonomics should examine well-identified professional practices as precisely and specifically as possible, the extreme narrowness of the field considered here (individual defensive activity in volleyball) is another limiting factor. For this reason, the potential for generalising our proposals is obviously reduced. This also applies to the method used, though we argue that the joint use of fine observation and interviews is a valuable means of studying activity for the purposes of understanding and transforming it.

Moreover, our study may be deemed too descriptive and not sufficiently based on numerical data. Because every volleyball match has its own course and intensity, we did not wish to give figures as they are contingent on the match in question (some matches are unequal and require just three sets, whilst others are more tightly fought and run to 5 sets); we preferred instead to focus on material with a greater potential for improving qualitative understanding.

Lastly, the complexity of the object of our study, combining defensive activity, high temporal pressure, sensemaking and situation assessment, as well as our joint theoretical recourse to activity-centred ergonomics and enactive approaches, led to an isolation of the situation assessment that is very much open to criticism. We are aware that in future studies it will be essential for us to link the situation assessment to its theoretical roots, those of the Situation Awareness and the Recognition-Primed Decision model - like Macquet (2009), from whom we borrowed a great deal.

5. Conclusions

The aim of this research was to explain what underlies the inter-individual differences in defensive behaviour between elite volleyball players. In so doing, the presented studies address, within a specific context, several important issues: (1) to understand the factors that determine different individual ways of acting when facing identical tasks, (2) to consider the relationship between the current action and "what counts as data in the first place" especially under high time pressure, and finally (3) to understand the way certain cues are recognised as relevant in a specific set of situation.

Our results lead to (1) an objectification and characterisation of differences between two populations of elite volleyball players in a defensive context; (2) the identification, for each population, of a specific overall coherence that orients and organises the defensive activity of its members. The identification of a norm organising and orienting the activity enhances the comprehension of the activity as a coherent totality. In fact, the various components of activity (behavioural facet and assessment by-products) appear to be the contextual actualisation, at various moments and according to the current circumstances of a broadly subconscious sense orienting individual activity. This sense seems to be at the root of the relevance of the cues for a subject in a specific set of situations and of his/her current action. This constitutes a hypothesis making progress in the intelligibility of the subconscious aspect of sensemaking. Especially under high time pressure, situation assessment and course of action seem highly coupled, but also organised and normed by this subconscious sense. If a subject has not enough time to consider several options before implementing one of them, our results lead to consider that this subconscious sense orients and organises the individual activity (the situation assessment and the current action). This normative aspect of sensemaking has to be challenged in different contexts, especially –but not only– in high time-pressure conditions. Finally, studying the sensemaking and approaching the prevalent norm that orients it would allow a subject's activity and the differences between the subjects to be understood. It should also contribute to explain why some people (here some players) have some difficulties to follow the prescription, including the role distribution in a collective organisation (here the game system). This is another hypothesis which has to be considered in future research.

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